A STUDY OF CERTAIN VEGETATIVE CHARACTERS OF SELECTED APPLE VARIETIES PYRUS MALUS

by

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TABLE OF CONTENTS

INTRODUCTION

The purpose of this study is to find plant characters that distinguish one apple variety from another in their dormant, fruitless and leafless condition. There has been no previous work done to identify commercially important varieties grown in the state of Kansas, purely from the standpoint of tree characters.

The value of such a study is apparent from the fact that there is no guide available that will aid in the identification of mature apple trees of different varieties. It is of value to the farmer who may have lost his orchard map and wishes to replace some trees because of defects or loss. It can be of help to a buyer of an orchard to verify the varieties claimed to be present in the orchard, as the sale of orchards usually takes place during winter months. It is of value to the department of horticulture for the same reason it is to the extension horticulturist or horticultural county agent. None of them has had a chance to study such a course in college. In fact, there is not a college in the country that offers definite work in the identification of fruit varieties purely from tree characters. This study has been of great value to the author through leading

into an entirely new field of work. Previous, similar work that has been done on apple varieties has dealt only with trees of nursery age.

REVIEW OF LITERATURE

Hovey (6) recognized the possibility of identifying trees of fruit varieties from tree characters as early as 1850. He states: "Although to an unpracticed eye little difference may be seen in many of the trees, to one who has studied them at all seasons, and in all their aspects—in spring when bursting into buds, in summer when wreathed with foliage, in autumn when weighed down with fruit, and in winter when divested of their verdure—they have an indescribable likeness which will at once enable all, who can appreciate the variable forms peculiar to trees, to recognize each variety." Even a statement like that did not stimulate sufficient interest to lead to a study of trees in their winter condition. He also gives twig and leaf characteristics together with fruit description. Although tree characters were recognized as an aid in identification by several other early writers of horticultural literature, the main attention was focussed on the description of the

fruits. Barry (1) in 1860 states that buds, color of young shoots, size and shape and type of growth of branches in peach trees are of value in separating varieties. Thomas (16) 1897, uses color of bark in distinguishing Northern Spy from Bellflower and shape of tree in separating the Gravenstein apple from trees of other apple varieties.

Beach (2) in 1905 was the first to study tree characters comprehensively and describe tree characters peculiar to each variety of apples. He used shape, size of trees, thickness and angle of branching, color of bark of one year old wood, and lenticels and their distribution. This is the first publication of its kind that devoted separate space to tree characteristics peculiar to each variety. Even in it the main object was the fruit description.

Shaw (11) in 1914 was the first to call attention to the need of such a study because of variety substitution in the sale of nursery stock. In this report he suggested the characters that might be of help in variety identification before the tree comes into bearing. He made an extensive study of leaf characters of apple trees in the nursery row and put out several publications at the subject (13) and (15). He worked on varieties important in the eastern portion of the United States. There is no publica-

lication, as far as the author's study goes, that will enable one to identify apple varieties based wholly on the dormant tree characters.

Shaw and French (15) have used shape of young nursery trees to supplement the identification by leaf characters.

Identification of peach, plum, and pear trees using tree characters together with leaf characters has been worked out by Upshall (18) in Canada. He uses degree and color of pubescence on terminal buds to separate pear varieties and states that "There is so little difference in growth habits and bark characters in peach varieties that little use can be made of them in distinguishing varieties, and therefore one has almost entirely to depend on shoot and leaf characters." He finds leaf glands of value in the identification of peach and plum varieties.

Gregory (4) has worked on the taxonomy of peach leaf glands and believes them to be of value in the identification of varieties.

Shoemaker (16) has put out a publication to help the nurseryman and horticultural inspector to eliminate variety substitution of peach trees in the nursery.

Grubb (5) and Winter (20) worked on raspberry plant characters to identify varieties. Grubb gives a key for

English Raspberry varieties. Winter states that these characters may vary for localities but holds them to be fairly constant for identification purposes. The location, abundance, color and structure of spines and also the prevailing number of leaflets and their color are their distinguishing characters used in raspberry identification.

Several questions arise in taking up this study: Are the tree tops grafted on various seedling stocks uniform in their shape? Is there any influence exerted on the cion by the stock that would change the characteristic varietal shape of the top? Does the root stock exert a dominating influence on cion or vice versa? Studies have been made by various investigators to answer questions of this nature. Roberts (8) and (9) presents pictures of typical root systems of several varieties to substantiate the statement: "Root character is as typical of a variety as is the top growth". He also says that the type and structural development of roots are affected by the cion variety, and holds that double worked trees have roots which are characteristic of intermediate (sandwich) variety. Roberts(10) further states; "Scion source is an important factor in tree uniformity and growth". He shows that the seedling size has an inconsistent effect on cion growth and states that nursery

trees tend to maintain the same relative difference, resulting from the first season's environment, when set in the orchard.

Shaw (12) also finds the domination of top so pronounced that the root system is of value to nurserymen in recognizing varieties; but states that "Within a given variety the form of root system is less uniform and less characteristic than the form of top." He does not find any definite arrangement in the roots. He also says that control of the bud or graft over the seedling root is pronounced. Pruning has considerable bearing on the shape of the top of a tree. Shaw (14) believes the modified leader type to be the natural form for most varieties of apples. He finds that the central leader fails to develop in a majority of apple trees, especially when the side branches were not headed back. Pruning has a dominating influence on the number, strength, and angle of branching.

All this evidence goes to show that the root stock does not have any dominant influence over the top, while the top modifies the root system characteristically for each variety. This is true with the exception of Paradise root stocks that have a dwarfing effect on cions of tall growing varieties. Roberts (9) says that stocks such as Paradise and

Doucin dwarf the top of trees when a regular tall growing variety is grown on them.

Hedrick (6) states: "Plants are as distinct as fruit and may be helpful in identification and classification in the absence of fruit. Size of tree is a reliable character to determine varieties of any of the pome fruits. In describing the tops of pome-fruit trees many self explanatory terms are used; as upright, spreading, drooping, tall, low, dense, open-topped, vase-form, and round-topped. Many if not most varieties may be told by the form of the top . . . The trunk counts for little in description of varieties because it is usually changed by pruning . . . . Color of bark is often a most valuable diagnostic character . . . . The branches offer several distinctive characters, some of which are very reliable . . . . The branchlets or twigs may be short or slender; straight or zigzagging; variously colored; some at certain stages of maturity are pubescent, others glabrous; the branching angle of branches is often characteristic; the epidermis may be smooth or covered with scarfskin, size, shape, color, number, and position of the lenticels on young wood are most important in identifying trees after the leaves have fallen".

Size, length, and shape of leaf buds help to identify

dormant trees. The shape may usually be described as acute, pointed, obtuse, conical or plump. If the bud lies close to the twig it is said to be appressed; if it stands at a considerable angle it is said to be free . . . . Whether the leaf-scar is conspicuous or inconspicuous should also be noted . . . . Flower buds offer the same marks for identification."

Shaw (15) has important suggestions regarding what to look for in a study of this kind. Although his work was largely on nursery trees and does not hold for older trees in many instances, some characters are very helpful in the identification of old trees as well. Regarding tree characters he says, "The varietal characters of growth, bark, bud, and wood are of great value in recognizing varieties. One depends upon them in about the same degree as on the leaves. When trees are dormant they are, of course, the only characters available."

For the size and vigor he says: "The size of an individual tree mostly depends upon age, soil, and on other environmental conditions, yet there are size differences that are of great value in recognizing varieties."

Form of top offers, according to Shaw (15) again, a very helpful character. The color of bark, which is always some shade of green, yellow or red is a very valuable char-

acter when studied on young shoots and older branches. Innumerable shades and blends of these colors occur on different varieties. Some varieties have irregular patches, distributed over the bark, of silvery color called scarf skin. This is another character of value.

Shoots and branches are helpful characters: the branching angle, which has an indirect effect on the shape of the top of the tree, their stoutness and slenderness marks a difference between varieties and branches on some varieties are straight and on others they are of zigzag appearance.

The appearance of buds on shoots and the angle at which they are attached is often characteristic of varieties. The fruit buds on spurs and the amount of pubescence on them is as valuable a characteristic as leaf buds on shoots. Lenticels are small corky dots scattered over the surface of the bark. They vary in number, size, location, and color in different varieties. They may be conspicuous or inconspicuous. They may be raised or sunken or even with the surface of the bark and are very characteristic on each variety.

MATERIALS AND METHODS

The commercially important apple varieties grown in Kansas were selected for study; namely, Arkansas, Delicious, Gano, Grimes Golden, Jonathan, Stayman Winesap, Winesap, and York Imperial. Ten mature trees of bearing age of each variety were selected for observation. Trees of normal size, health, and vigor were selected. Differences in shape and size within the variety are apparent in trees under different treatments such as straw mulch and non-mulched rows, and also under different soil conditions as low spots or a hill top. Such variations were avoided in selection.

Observations of tree characters were made in the field, weather permitting. Cuttings of at least up to three year wood were obtained to take notes on characters of young shots, color of bark, buds, pubescence, scarf-skin, and lenticels. These cuttings were kept with their cut ends in water to keep them fresh. Photographs of different varieties of trees were also taken to present with the manuscript. Other photographs to facilitate the explanation are also presented.

The observation of trees in the orchard at frequent and occasional intervals is very necessary to get acquainted with tree characters. One fact, however, should not be neglected in preparation of a manuscript of this kind: "No one can learn to know varieties from the printed page even when supplemented with an abundance of good illustrations; the trees must be studied as they stand in the orchard."

The identity of varieties was established from an orchard map of the department of horticulture. One variety was thoroughly studied and then work was begun on another variety with a view of finding how it differs from the one already studied and the rest of the varieties in question. The hardest task encountered is in these Winesap group varieties, Winesap, Stayman Winesap and Arkansas, in their bark, color and lenticel characteristics. The trees present distinctly separate habit of growth characters.

The most difficult task is to put down on paper the colors in definite words. "It is far from easy to pick out the points used semi-consciously for identification."

DESCRIPTION OF APPLE VARIETIES

One order to arrange descriptions of apple varieties is to list them alphabetically and other investigators describe them in the order of their commercial importance. To the writer it has seemed best to divide the varieties into three classes on the basis of bark color; namely,

I. Greenish to olive green: Jonathan, Grimes Golden, and York Imperial.

II. Orange red to light brownish-red: Gano.

III. Dark brownish-red to purplish-red or approaching black: Delicious, Stayman Winesap, Winesap, and Arkansas.

These colors represent the tree colors when examined at a glance taking the tree as a unit, because the color of one year old wood always has some shade of red no matter in which of the three color divisions it falls. These colors are blends of the three primary colors red, blue and yellow.

Bark color varies widely on any individual tree. Bark exposed to direct sunlight shows more red in its color whereas shaded bark takes on a greenish tinge. Also the "finish" varies due to the same environmental factor, the south exposure being glossy and the north dull.

In describing the characteristics of varieties the following outline will be used. The same outline was used in studying each variety:

Tree:

1. Size
2. Form
3. Color as a whole

Limbs and Branches:

1. Angle of branching
2. Comparative diameter
3. Scarf skin and sloughed material

Young wood - one to three years:

1. Scarf skin
2. Bark color
3. Pubescence

Buds:

1. Terminal on twig
    a. Size
    b. Pubescence, degree of
    c. Bud scales
2. Lateral on twig
    a. Attachment
    b. Pubescence

c. Size

(1) On lower third of twig

(2) On middle third of twig

(3) On upper third of twig

3. Terminal on two-year old spur

a. Size

(1) Color of bud scales

(2) Pubescence

Lenticels:

1. Number and color
2. Size, comparative
3. Distribution
4. Prominence

Leaf scars:

A few points included in the outline but not previously discussed should be explained before describing variety characteristics.

The color of a mature tree as a whole is different from that of a tree that is one to six years old. The color of terminal wood or twigs, however, has been found to be the same on old and young trees of the same variety. The characteristic twig color is entirely different from tree color seen at a glance. The tree usually has a grey-

ish-white coating of sloughed material*, which can be removed in small flakes when scraped, and is referred to as scarf-skin on young wood, because it is only one or two cells thick.

The young shoots, when actively growing, on practically all apple varieties have a uniform covering of pubescence, but as the wood matures the pubescence falls off. The degree of its disappearance from twigs seems to be characteristic of varieties. The scarf-skin has been found under pubescence every time the latter was carefully brushed off. The writer has reason to believe that the degree of scarf-skin on one year old wood is correlated to the degree of pubescence.

The best wood for a study of lateral buds is the middle third of the twigs, although sometimes two-thirds of the top third of the twig could be included. The buds on this portion are well developed, normal, and bring out the distinguishing characteristics more distinctly than the buds on the lower third of the twig or the few buds closely below the terminal bud. Shaw (13) in studying the leaf characters of apple varieties says that the leaves in

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* This material(when examined under a microscope) is two or more cell layers thick, of greyish-white color, and is on the outside of the corky cell layers of the bark.

the middle third of the twig should be considered and the others excluded because they are small, and present various shapes. The same is true in the study of lateral buds. The first three to six nodes at the base of a twig either do not have any buds on them or, if any, they are small and weak.

The number of lenticels has been denoted as few, moderately numerous, numerous, and abundant. Their size is described as small, medium, medium large, and large. Some varieties have lenticels level with the surface of the bark and others have sunken or raised lenticels. In certain varieties the lenticels are large, distinct, and prominent; while in others they are indistinct or inconspicuous. The shape of lenticels varies from round to roundish oblong or sometimes almost diamond shaped. The two year old wood is found to be the most consistent area for characteristic lenticel study.

The leaf scars, in certain cases, are an important means of identification; they are either prominent, small, or large. The angle they form with the twig when viewed in profile is a character that offers means of distinction in certain varieties.

Class 1. Tree greenish to olive green:

1. Jonathan:

Tree.—The Jonathan tree is medium to medium large in size. The form is roundish spreading (Fig. 1). It is light grey in color with a greenish tinge. This greenish shade is distinct on shaded bark.

In a "photographic exposure view" the tree looks as though it has greyish-white cotton "tufts" tied at the tip of each twig, which is explained in a study of terminal buds. Without close study the tree might be confused with Grimes Golden and, more or less, with the York Imperial.

Limbs and Branches.—The angle of branching of Jonathan is wider than it is in York Imperial and a little wider than that of Grimes Golden. This wider angle of branching makes it an open type of tree. The limbs and branches have the smallest diameter of any tree in the class. They are long and slender, tapering gradually as they approach the tip. Branches are smooth in appearance. The twigs are very slender and are straight "switches". The tree has a dense appearance occasionally. Limbs and branches are covered with abundant sloughed material which is responsible for the light grey color of the whole tree.

Figure 1. Jonathan; note the spreading and open form of the tree with long slender branches, especially in upper half.

Young Wood.—Small branches, one to three years old, have very nearly the same color as older bark. One year old wood is of light reddish-brown color with a tendency to be orange-red and a distinct blend of olive green in it. Two and three year old wood is less reddish-brown and shows more olive green mixed in it than on twigs. A thick coat of scarf-skin could be seen, starting in the middle of the twig, in patches to a uniform covering toward the tip of the twig.

Pubescence on one year old wood is very marked. Twigs are pubescent in patches at the base, but from the middle up they are more thickly covered with pubescence. In other words the twigs have a "woolly" appearance.

Buds.—The terminal buds on twigs are the ones that give a tufty appearance to the tree. These buds are large, plump, and thickly covered with pubescence. This is the outstanding characteristic of the Jonathan tree in distinction from others of this class.

Lateral buds on one year old wood present distinguishing characteristics as to their attachment to the twigs, appressed or free, and pubescence. They are pubescent but not as much so as the terminal bud. These buds are free,

large, plump, and acuminate. The lower one-third of the twig bears buds that are usually weak, and in some cases the first three or four nodes do not have buds (Plate IA).

The terminal buds on spurs are plump and round with a rounded or blunt tip. They are very pubescent, as much pubescence as the terminal buds of twigs. This is another outstanding character in Jonathan. No tree in this class has buds with such a heavy pubescence (Plate IIA).

Lenticels.—Two and three year old wood are better for study of lenticels. Some lenticels (that are in the stage of development) on twigs entirely disappear on two year wood or they become indistinct.

Lenticels on Jonathan are moderately numerous, especially about the middle of the year's growth. They are medium large, most of them are roundish in shape with a few that tend to be roundish oblong. They are light tan in color.

2. Grimes Golden:

Tree.— The Grimes Golden tree is medium to large in size. It is an upright grower but tends towards a spreading habit of growth and has a roundish form. The tree is more upright than Jonathan, but less vase-shaped or compact than York Imperial (Fig. 2). The color of the

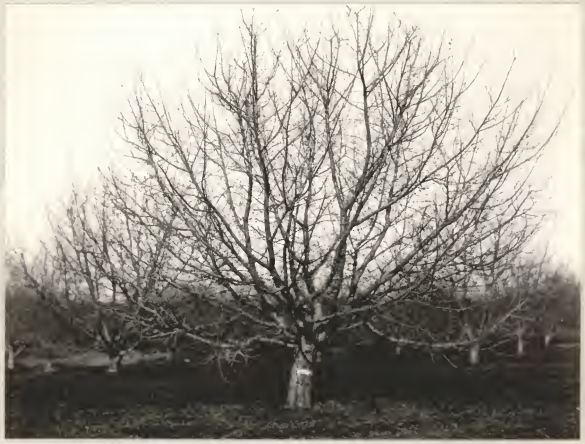

Figure 2. Grimes Golden; tree comparatively more compact and upright than Jonathan; branches moderately stout.

tree, as a whole, is light greyish olive green with a dull finish. It shows more green than Jonathan.

Limbs and Branches.—The angle of branching is narrower than in Jonathan but wider than of York Imperial. The limbs are numerous and moderately stout, more curved and stouter than those of Jonathan. The branches are numerous and give the tree a dense appearance. They taper gradually towards the tip. The sloughed material on branches is very marked but less abundant than it is on Jonathan branches.

Young Wood.—One year old twigs are of brownish-red color with a tint of olive green. The two year old wood is of brownish-red color with a distinct olive green shade. The olive green color in bark is more conspicuous than it is in Jonathan (Plate IIIB).

The twigs have scattered patches of pubescence and also a thin coating and mottling of scarf-skin. The twigs are pubescent at the base and tip but the degree of pubescence is low, not half so much as on Jonathan.

Buds.—The terminal buds on twigs are large, pointed, or acute, and long. They are pubescent, more heavily so at the tip. The pubescence does not give the tree that tufty appearance which the Jonathan has, and which is a first and rough character to distinguish between

the two varieties. Bud scales are covered with a light pubescence.

The lateral buds are medium in size. They are narrow and pointed or acute. They are all pubescent at the tips with generally smooth bud scales, but some of the bud scales also have a light pubescence on them. This is commonly so if the buds are located in a pubescence patch on the twig. They are generally appressed, but rarely free. They are not as large as Jonathan buds. The buds at the lower part of the twig are very small and bear no pubescence even toward the tip of the buds.

The terminal buds on two year old spurs are narrow, long, and acute* offering another very important character of distinction from other varieties in this class. The spurs are usually attached at a wider angle than in Jonathan but it is narrower than the spur angle of York Imperial. The buds are thinly covered with pubescence, sometimes none at all.

Lenticels.— The lenticels on two or three year old bark are very numerous but a large per cent of them are small and indistinct. A few are large and tend to

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*It was observed later in the spring these buds were practically all leaf buds, which may account for their narrow and acute form.

be inconspicuous. They are oblong to roundish-oblong; the larger ones are mostly oblong and have a diamond shaped appearance when examined under a magnifying glass. They are evenly distributed over the entire surface and are of dirty greyish-tan color. They are level with the surface, though a few tend to be sunken. Lenticels are more numerous than on Jonathan (Plate IIB).

The leaf scars are smaller and more prominent than they are on Jonathan, and the scar shoulders* are not as prominent as they are on the Jonathan twig.

3. York Imperial:

Tree.—The York Imperial tree is upright but rather spreading in growth. It is medium large in size, with roundish, rather dense form. The color of the tree is dull green with a very faint tinge of green but not so pronounced as in Jonathan and Grimes Golden. The form is more upright and compact than in other varieties in this class (Fig. 3).

Limbs and Branches.—The angle of branching is comparatively acute, which is responsible for the upright and compact form of tree. The limbs are stout. The branch-

*Raised ridge of bark below the scar left on the twig after the leaf dropped off.

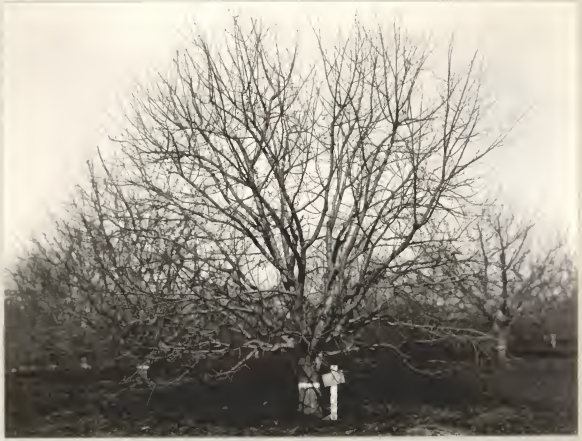

Figure 3. York Imperial; tree compact, upright and vase-shaped; branches stout with an abrupt change in diameter into the tip wood.

es are numerous and stout, or are the most stout in the whole class, with an abrupt decrease in diameter toward the tip wood (Fig. 3). In other varieties of this class there is a gradual tapering off. The sloughed material is almost white or very light grey and gives the tree its characteristic white washed appearance.

Young Wood.—The twigs are very slender and are mottled with thin patches of scarf-skin coating, occasionally streaks of scarf-skin can be observed. They are also pubescent but only in spots (Plate IC). The two and three year wood shows rather an abrupt increase in diameter. Bark color of twigs is brownish-red with a shade of olive green. The color of bark on two to three year old wood shows more olive green than in one year old (Plate IIIC). Sloughed material on the bark of four to six year old wood has a russeted appearance.

Buds.—The terminal buds on twigs are rather small, plump, and are round or acuminate. They are not as large or as pointed as in either of the other two varieties in this class. The terminal bud is pubescent, near the tip with glabrous bud scales at the base.

The lateral buds are small, weak, and inconspicuous in the lower portion of the twig, but in the middle of the

twig they are of medium size. They are appressed except the larger ones which tend to be free. They are pubescent, and to a marked degree near the tips of buds (Plate IC).

The terminal buds of spurs on two year old wood are small, plump, and pointed*. The spur is attached to the branch at a very wide angle, the widest in the class and approaches almost 90 degrees (Plate IIC). These buds are pubescent at the tips and the bud scales have no pubescence except at the very edges, giving the buds a netted appearance. The bud scales are glabrous and of dark brownish-red color.

Lenticels.—Lenticels on York Imperial are less numerous than on the other varieties of this class. They are distributed somewhat evenly over the twig, and are roundish in shape. They may be a little raised, but are almost level with the surface of the bark. They are light tan in color and conspicuous. They are not as large as those on Jonathan or as indistinct as on Grimes Golden twigs. Leaf scars on twigs are large and prominent.

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* York Imperial being a biennial bearer had leaf buds on the spurs in 1932.

Class II: Orange-red to light brownish-red:

1. Gano:

Tree.—The Gano tree is upright and dense. It is of compact or vase-shaped form with a roundish top. This tree is the most upright and compact in form of all the varieties included in this study. The winter color of the tree is brownish-orange red with a tinge of olive green. The tree bark color has a very glossy appearance and reflects a lacquered shine. The color is the outstanding character of this tree that first catches the eye (Fig. 4).

Limbs and Branches.—The angle of branching is narrow and gives the tree its compact, upright form. The limbs are moderately stout. They are straight with numerous branches giving the tree its dense appearance. The limbs and branches have a very light coating of sloughed material. This material is not so thick as in other varieties, and it does not greatly affect the color of the tree. The branches also have a very thin coating, but it is not noticeable. The branches are slender, gradually tapering out to the tip wood with an abundance of laterals (Fig. 4).

Young Wood.—The twigs have a thin mottling and streaking of scarf-skin (Plate ID) which is especially

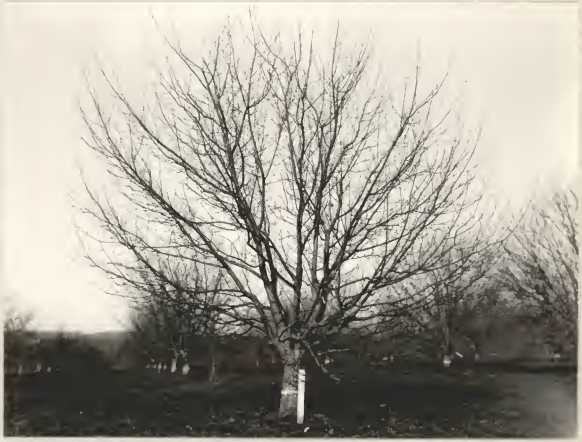

Figure 4. Cano; tree pronounced vase form; branches straight and thin.

noticeable on wood two and three years old. The twigs are lightly pubescent at the base, in the middle, and at the tips.

The color of the bark on one year old wood is bright and light reddish-brown blended with a shade of olive green. The color of two and three year old wood is about the same with a darker shade of green on the shaded side, where an orange red color also becomes dominant over the light brownish-red (Plate IIID). The absence of scarf-skin on twigs makes them shiny.

Buds.—The terminal buds on twigs are large, plump and acuminate (Plate ID).

The first three or four lateral buds at the base of the twig are very small, weak, and not pubescent. They seem to be deeply set in the bark due to the large leaf scars (Plate ID). Sometimes there is more pubescence near the tip than at the base of lateral buds. Exposed or glabrous bud-scales are brownish-red in color. The two year old wood has spurs on it at an angle of about 45°.

Lenticels.—Gene lenticels are very few in number and are of medium size. They are scattered over the year's growth, and are distinctly raised above the surface of the bark. They are round to roundish-oblong in shape and are light tan in color.

The leaf scars are very prominently raised making the adjacent lateral buds look deeply sunken in the twig (Plate ID).

Class III. Dark brownish-red to purplish-red, or approaching black:

General Comparisons:-All the varieties included in this class, according to the tree color, belong to the Winesap group of apples. They offer very distinct characters in the tree form (Figs. 5, 6, 7 and 8). In studying the twig characters great difficulty is encountered to separate one variety from another with the exception of Delicious. The twig color aids in separating Arkansas from Winesap and Stayman Winesap.

Stayman Winesap and Winesap are most nearly alike in twig characters. The characteristics such as lenticels, their number, size, and location; lateral buds, etc. are very difficult to identify unless a constant study is kept up and the minute differences carefully noticed. Even then some twigs are encountered that are stumbling blocks in the separation of the two varieties.

A thick "mosaic" of small and large lenticels is found in clusters, in all these varieties, on or in the area where the annual ring is left by the scale scars of the terminal

bud of a twig and on the bark immediately below the leaf scar. These clusters of lenticels may also be found at any place in the middle or lower portion of the year's growth, either on twig or on wood two or three years old. Most of these eventually disappear on three year old wood, and almost entirely so on four year or older wood. These clusters of lenticels are not found outside of the area around bud scale scars on Delicious.

The large lenticels on two and three year wood offer a means of distinction between Arkansas, Stayman Winesap, and Winesap. The small lenticels are of no value in identification within the group, but they are very valuable in separating this group from the other varieties, included in this study, which do not have this "mosaic" of lenticels.

1. Delicious:

Tree.—The Delicious tree has an upright habit of growth. Usually it is a dense appearing tree with compact roundish form. The tree is medium to large size (Fig. 5). The color of tree as a whole is dark brownish-red with a grey coating of sloughed material, especially on the limbs and larger branches.

Limbs and Branches.—The limbs and branches are moderately stout and are rather straight, but not as

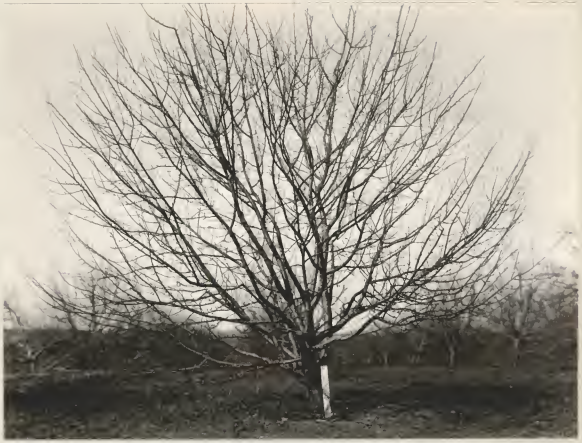

Figure 5. Delicious; tree vase shaped and compact with numerous straight branches; numerous characteristically straight young spurs.

straight as in Ohio. They have a coating of sloughed material giving them a grey brownish-red color.

The branches are numerous, moderately slender, and straight without any very sharp crooks in them, and give the tree a rather dense and compact form. The branching angle is the narrowest of the varieties in this class. The limbs and branches, in Kansas, almost always bend away from the direction of winds and are usually curved to the northeast (Fig. 5).

The branches are full of short spurs and are characteristically straight. The branches have a moderately thick coat of scarf-skin.

Young Wood.—There is a thin coat of scarf-skin in patches and sometimes it may be found in streaks on the young wood. Pubescence is more abundant near the tip and is found in patches on the twig, and is of very dark grey color. The bark color of twigs is very dark brownish-red with a faint purplish tinge and a blend of olive green color which is more marked on the shaded side of the twig. The color of two to three year old or older wood is light brownish-red with a darker shade of olive green (Plate IIIE).

Buds.—The terminal buds on twigs are large,

round, rather pointed and plump. The bud scales are pubescent.

There are no lateral buds on the first four to five nodes, which are much crowded. Few buds below the middle third of the twig are appressed, acute, and of medium size, with pubescence at the tips. Buds in the middle portion of the twig and up to the terminal are large, plump, acute to acuminate, and pubescent (Plate IE).

The terminal buds on spurs are medium large, plump and rather pointed. They are pubescent only at the tips and a little on the edges of bud scales. The bud scales are of very dark brownish-red color.

Lenticels.--The "mosaic" of lenticels, referred to before, is on and immediately above the bud-scale-scars-ring area. Outside of this area the lenticels are very large, round, of light tan color, abundant, and fairly evenly distributed over the surface. These lenticels stand out very prominently and catch the eye of the observer. No other variety studied has such outstanding, large, and light colored lenticels (Plate IIE).

The leaf-scars on Delicious are moderately prominent. The bark ridge below them forms almost a 90° angle with the twig, which is easily seen in the case of ones that do not

have any bud next to the scar.

2. Winesap:

Tree.—The Winesap tree is of medium large size. It is a very round and symmetrical tree with a spreading and rather dense habit of growth. It tends to be drooping (Fig. 6). The top of this tree presents the best characteristic for distinguishing it from Stayman Winesap. The outerhalf of the Winesap tree presents strikingly geniculate branches with drooping and recurved branchlets, while on Stayman Winesap the branches are straight and upright (Fig. 6).

The color of the tree as a whole is dark brownish-red with a grey coating of sloughed material, especially low on the branches and limbs.

Limbs and Branches.—The limbs are comparatively stout, more so than those of Stayman Winesap. They are distinctly geniculate in growth habit. They are covered with a thick coating of grey sloughed material. The limbs and branches are quite numerous and give the tree a dense appearance. The angle of branching is a trifle wider than with Stayman Winesap.

The branches are numerous and moderately stout. They have a zigzag or strikingly geniculate growth habit (Fig. 6).

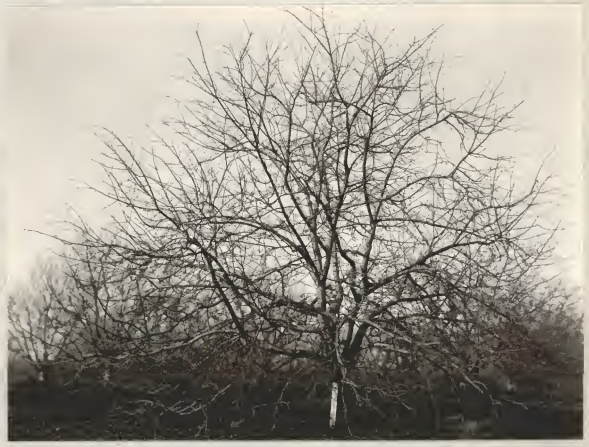

Figure 6. Winesap; note the pronounced geniculate growth of branches and twigs in outer half of tree.

Young Wood.—Winesap twigs are covered with a light cast of scarf-skin and it also may be found in streaks. The twigs have a covering of light pubescence, sometimes found only in patches; it is of dark grey color. The twig color is very dark brownish-red with a faint olive green tinge and showing a decided shade of purple (Plate IIIF). The two and three year old wood takes on a darker shade of olive green with almost no purple with brownish-red dominating but not so intense as on twigs (Plate IIIF). The color of older wood shows a lighter color because of sloughed material coating over the bark increasing in thickness. The scarf-skin on two year old or older wood may be found in netted form or streaks.

Buds.—The terminal bud on a Winesap twig is large but not as large and long as it is on a Stayman Winesap twig. The bud is acute to acuminate. It is lightly covered with pubescence.

The lateral buds on twigs are medium in size and are not as large or as long as those on Stayman Winesap. The lower two or three buds on the twig are weak, very small, and pubescent only near the tips. These lateral buds are rather acute and terminate in a sharper angle at the tip than those on Stayman Winesap twigs. Most of these buds are

pubescent but some may be pubescent only near the tip, thus exposing the bud scales which are of very dark brownish-red color.

The terminal buds on two year old spurs are medium sized and acuminate in shape. They are lightly covered with pubescence. They are usually smaller in size than those of Stayman Winesap.

Lenticels.—The lenticels are clustered on the bud-scale-scar-ring area and above and below it. They are also clustered on the bark immediately below the leaf scar and may also be found in other locations. They are very numerous in a cluster, very small to large in size, and are not evenly distributed. The larger and isolated lenticels are not as numerous or as large as on the Stayman Winesap. They are of light greyish or light tannish color.

Leaf Scars.—The leaf scars are not very prominent but more so than they are on Stayman Winesap. When seen in profile they form an angle of about 90^{0} or a little larger but the angle is not as wide as that of the Stayman Winesap. This is the most reliable character in distinguishing Winesap twigs from those of Stayman Winesap.

3. Stayman Winesap:

Tree.—The size of the Stayman Winesap tree is medium large to large. It has a roundish, somewhat

spreading form. It is rather an open type of tree (Fig. 7). The tree in form approaches very near to Jonathan, except the color of tree which is markedly different. The color of tree is dark brownish-red with a grey coating of sloughed material on limbs and the lower part of larger branches. There is a purplish tint.

Limbs and Branches.—The limbs are stout and straight. The branches tend to curve upwards. The angle of branching is wide. The branches are long and numerous, and are covered with a comparatively thick coat of sloughed material. The branches gradually taper out to the tip wood. They might in certain cases be confused with Delicious; but it is more open or not as compact as Delicious and its branches are upright whereas those of Delicious are bent a little to the northeast.

Young Wood.—The twigs have very dark brownish-red color with a shade of olive green. There also can be seen a distinct tint of purple. The bark color of two and three year old wood has as the dominating color dark brownish-red with olive green rather pronounced, and practically no indication of purple.

The twigs are markedly pubescent except near the base where there is pubescence either in patches or none at all.

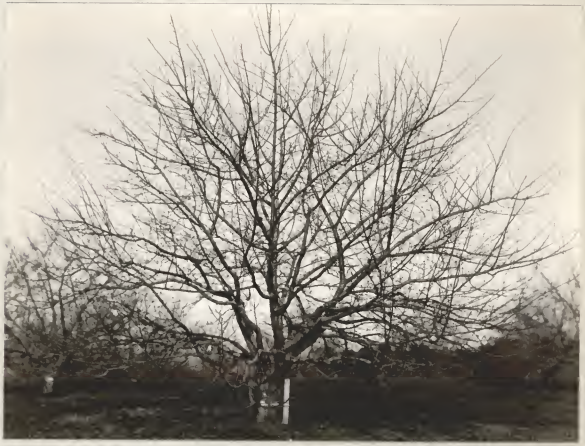

Figure 7. Stayman Winesap; tree spreading, moderately open with upright and moderately stout branches.

Heavier pubescence on the twigs is one of the characteristics that distinguishes Stayman Winesap from Winesap.

The scarf-skin on three to four year wood shows a netted appearance. On twigs there is a very thin coat of scarf-skin. It sometimes occurs in patches only.

Buds.- The terminal buds on twigs are large, plump, long and rather pointed. They are markedly pubescent. The pubescence is of dark grey color. The terminal bud is almost always larger than that on a Winesap twig and also is heavily covered with pubescence.

The lateral buds are large, rather larger than those on Winesap, and are more pubescent at the tips than at the base of the bud. This characteristic may help in distinguishing Stayman Winesap wood from Winesap but is not always reliable. The lateral buds in the middle of the twig tend to be rather free, but elsewhere they are generally appressed (Plate IG).

The terminal buds on two year old spurs are large, plump, rather long and pointed and heavily coated with pubescence, more at tips of buds than at the base.

Lenticels.—The lenticels are very numerous and are found in a "mosaic" near the terminal bud-scale scars area and in the area immediately above and below it.

They are also almost invariably found on the ridge below a leaf-scar and frequently in clusters over the twigs almost anywhere, without any regular occurrence (Plate IIG). Generally there is a larger area occupied by this mosaic of lenticels immediately above the annual bud-scale scar ring in Stayman Winesap than it is in Winesap (Plate IIG). The isolated lenticels that are found on wood are more numerous and little larger in size than the isolated lenticels on Winesap. The lenticels are round and roundish-oblong. They are few in the upper half of the twig except few large ones which are light tan in color.

Leaf Scars.— The leaf scars are the most reliable of characters in distinguishing Stayman Winesap from Winesap. The scars when seen in profile form an obtuse angle, much larger than 90°, with the twig, whereas in Winesap this angle is either about 90° or only slightly larger than 90° but never as large as on Stayman Winesap.

4. Arkansas:

Tree.—The Arkansas is very large tree with a spreading and open top. It is too open a tree to be classed as a round tree. It has a straggling and spreading habit of growth. The tree shows from very dark brownish-red to purple or almost black color, but the limbs are covered with sloughed material which is very thick and gives the

tree a dark grey over-color. This is the darkest colored tree of the varieties studied. A very open top, some limbs growing out almost horizontally, together with the tree color give the outstanding means of identification at first sight (Fig. 8).

Limbs and Branches.—The angle of branching is from medium to wide and is very inconsistent. The main limbs are fairly numerous and grow in almost all directions from horizontal to vertical. The limbs have a tendency to be geniculate which, however, is not very pronounced. The limbs are very stout, the most so of all the varieties included in this study (Fig. 8).

The branches are numerous, in spite of the fact that the tree presents an open form. They have a fairly thick coat of sloughed material which gets lighter as the tip wood of a branchlet is approached. The limbs have a thicker coat of sloughed material than branches do. The branches tend to be curved in a smooth arc, but not as much so as the branches of Stayman Winesap. The branches are only moderately stout.

Young Wood.—The twigs have a very dark brownish-red color with a shade of purplish-black. The twigs are covered with dark grey pubescence which is more abundant near the tip. There is a light mottling or coat-

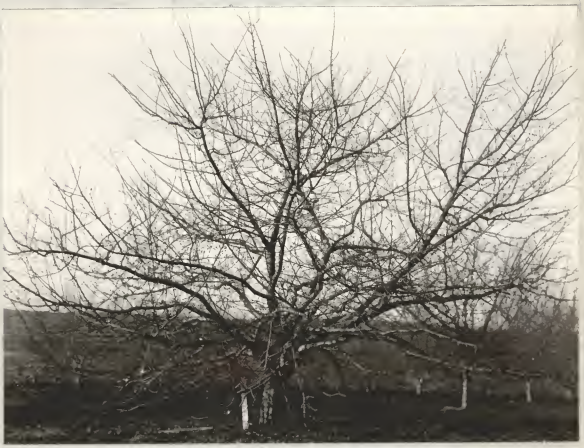

Figure 8. Arkansas; note the straggling growth of limbs, very open top and the pronounced stoutness of limbs.

ing of scarf-skin in patches.

The two year old and older wood shows less intensity of dark brownish-red color (Plate IIIH). On older wood the olive green color becomes fairly prominent.

Buds.- The terminal bud on a twig is large, acuminate, and plump. It is heavily covered with dark grey pubescence. Pubescence on Arkansas has a very soiled appearance.

The lateral buds are of medium size, pubescent, and acuminate. They are quite free except a few near the tips and two or three up from the base of the twig.

The terminal buds of spurs on two year old wood are medium in size, plump and acuminate. They are lightly pubescent.

Lenticels.- The lenticels are massed, the same way as on all other Winesap group trees studied, on the terminal bud-scale scar ring area and the area above and below it. Very few lenticel clusters, if any, are found between these rings. The lenticels on the wood between the annual bud-scale scar rings are conspicuous, of light grey color, medium in size, roundish in shape, and are raised above the surface of the bark. They are conspicuous because of their light color on the very dark, almost black, color of the bark. They are numerous.

Leaf Scars.— The leaf scars are fairly prominent. The angle they form with the twig lies between that formed by a leaf scar on Winesap twig and that on a Stayman Winesap, but it is of no particular value in identification. The other characteristics are more reliable than this.

RESULTS AND DISCUSSION

The results obtained in this study show conclusively that the varieties of apples which came within the scope of this study could be identified during the dormant period by certain vegetative characters. The growth habit of a tree together with minor characteristic differences make possible such distinctions. Numerous twigs should be examined to obtain a characteristic difference between any two varieties, because occasionally a twig is encountered that does not show all the characteristic differences as clearly as expected and sometimes a certain point might not be distinguished at all. There is as wide a variation in the wood characters within a variety as there is in the fruit characters of the same variety.

This study will hold good for this locality but the

writer is not sure whether it will hold for places having different environments, because certain tree characters change with the change in environment. Amount of direct sunlight or number of clear sunshiny days in a locality is a big factor in its effects on the color of tree. The wood is more of a greenish color right after the foliage is off of the tree than it is on the same tree a month afterwards. The color shades get darker and darker with the long exposure to the winter sunlight. Anthocyans, or red pigments, are developed largely as a result of direct sunlight falling on the bark, hence an eventual increase in the brownish-red color. These red pigments were found, by microscopical examination of the cross section of a twig, to be present in the corky layer of cells and in the cork cambium cells outside of the parenchyma tissue.

The pubescence has been found to vary as the age of wood progresses. The young shoots are all heavily covered with pubescence in all apple varieties but as the wood matures the pubescence may blow off and it might be found only in patches or in a streak on the side of the twig that is protected from direct wind action.

All these characteristic, distinctive marks on young wood or twigs check fairly close to those recorded briefly by Beach at Geneva, New York. From the comparison of

results of the author and those recorded in New York certain of the characteristics seem to be fairly constant, excluding such as vigor and size of tree that are affected by the fertility and moisture conditions of the soil.

As a result of this investigation a table or key of significant distinguishing characteristics of each variety studied has been worked out.

THE KEY FOR VARIETAL IDENTIFICATION

Class I.

A. General tree color, dull green to light greyish-olive green; twig color, light brownish-red with distinct olive green blend.

1. Twigs highly pubescent, terminal buds of tufty appearance, large; lenticels, moderately numerous, raised; terminal buds on spurs, markedly pubescent; most acute spur attachment; tree, open, spreading, upright; limbs, slender. . . . JONATHAN

2. Twigs pubescent in spots; terminal buds of twigs and spurs pubescent at tips, lower bud scales glabrous; lenticels abundant, indistinct, level or sunken; tree less

open, limbs, moderately stout; medium angle of spur attachment. . GRIMES GOLDEN

3. Twigs sometimes have streaks of scarf skin; terminal buds of twigs and spurs are small, with pubescence at tips and edges of bud scales which are mostly glabrous; widest spur attachment angle; fewer lenticels; tree upright compact, limbs and branches stout with an abrupt decrease in diameter toward the tips. . YORK IMPERIAL

Class II.

A. Tree very compact and upright, bark color brownish-red to light orange red, very shiny; lenticels are fewest and distinctly raised; leaf scar shoulders very prominent. . . . GANO

Class III.

A. Tree color dark brownish-red to almost purplish-black; lenticels clustered on and around terminal bud scale scar rings.

1. Lenticels large and very bright greyish-tan, numerous, distinctly raised; bark shiny and of distinct purplish-red color; tree upright and compact. . DELICIOUS

2. Lenticels, found in clusters scattered over the twig;

   a. Tree upright and spreading, limbs and branches straight; twigs highly pubescent except near base; terminal bud, large and highly pubescent; profile view of leaf scar angle with twig is widest in the class. STAYMAN WINESAP

   b. Tree round, compact and bushy; limbs and branches geniculate; terminal bud, medium sized and lightly pubescent; profile view of leaf scar angle with twig is smaller. WINESAP

   c. Tree, very open, straggling; limbs are most stout, some almost horizontal; bark color decidedly purple to almost black; lateral buds free, large and pubescent. . . . ARKANSAS

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APPENDIX

Plate I

Twigs showing terminal buds, lateral buds, pubescence, scarf-skin, and leaf scars. Some of these are not truly representative because it was difficult to find twigs without hail injury. The twigs are from:

A. Jonathan
B. Grimes Golden
C. York Imperial
D. Gano
E. Delicious
F. Winesap
G. Stayman Winesap
H. Arkansas

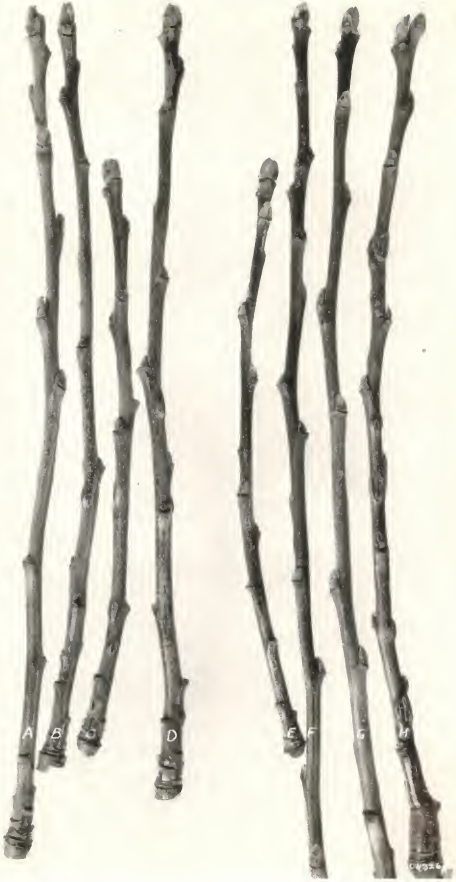
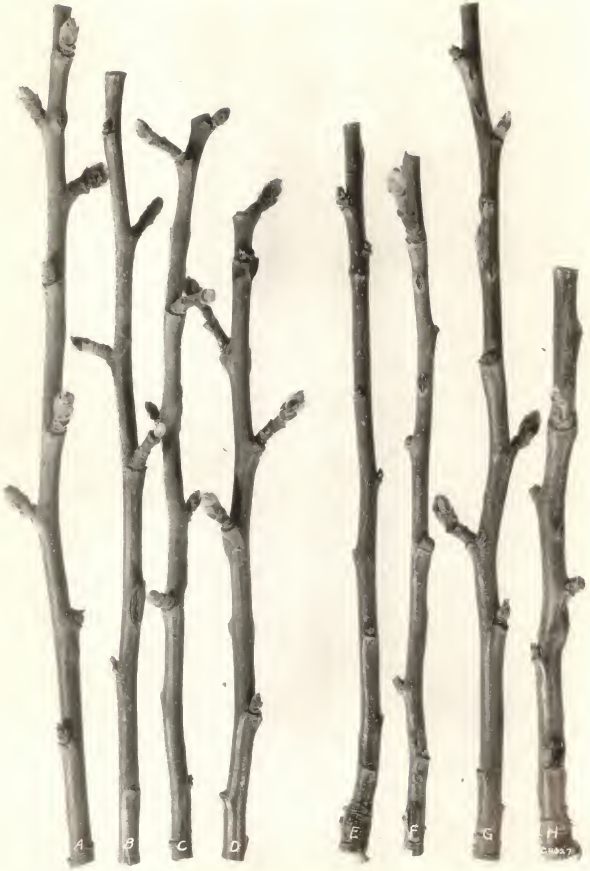

A
B
C
D
E
F
G
H

Plate II

Two year old wood showing characteristic lenticels and spurs on the following varieties:

A. Jonathan
B. Grimes Golden
C. York Imperial
D. Geno
E. Delicious
F. Winesap
G. Stayman Winesap
H. Arkansas


A
B
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D
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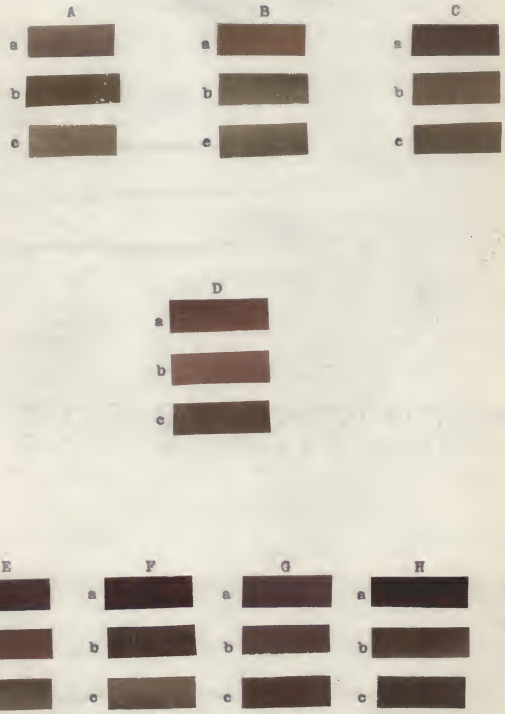
Plate III

This chart shows the color of wood from one to three year old. It will be noticed that the brownish-red decreases in intensity as we go from one to three year wood which, however, represents the tree color fairly well. Letters a, b, and c on plate refer to color of one, two and three year old wood respectively:

A. Jonathan
B. Grimes Golden
C. York Imperial
D. Gano
E. Delicious
F. Winesap
G. Stayman Winesap
H. Arkansas

Plate III



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